GENERAL INFORMATION MANUAL
dp/p 4000 SERIES LINE/PRINTERS

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Figure 1a — The Series 4000 LINE/PRINTER Front View

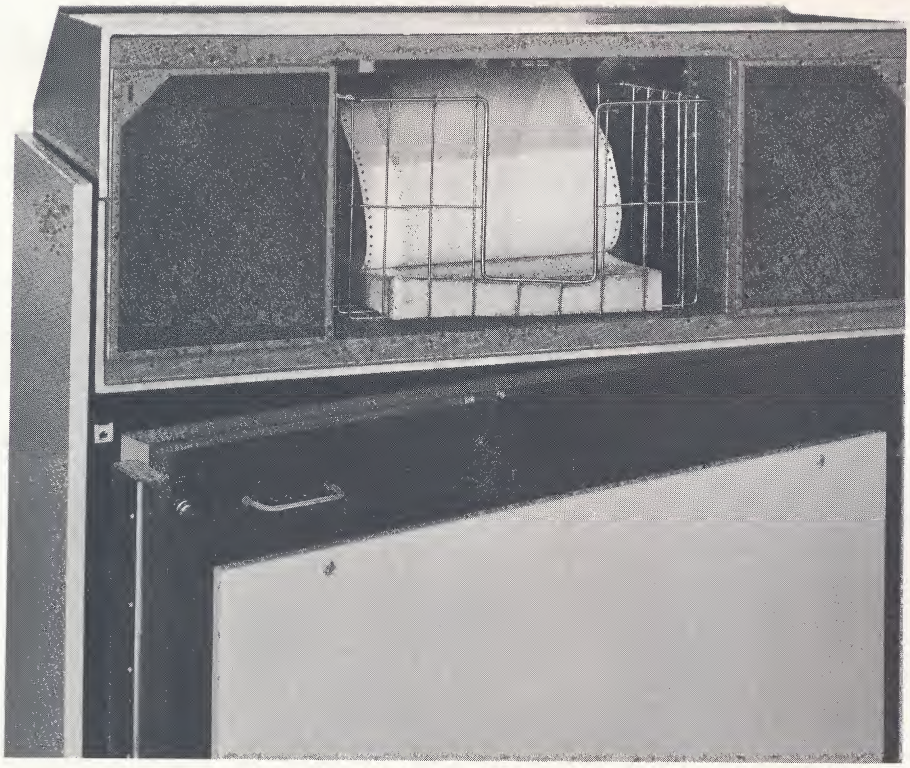


Figure 1b — Rear view showing paper receptacle doors open, and partly open Electronics Gate

DESCRIPTION

INTRODUCTION

The dp/p-4000 Series LINE/PRINTERS are highly reliable systems which produce printed copy from binary coded information supplied by a data source. They print numerals, letters, and symbols on fanfold forms or on tabulating cards.

These LINE/PRINTERS are used on-line with digital data systems of all kinds, or off-line with paper and magnetic tape units, communications terminals, and similar devices.

The dp/p-4000 Series LINE/PRINTERS print lines of up to 132 print positions at rates of from 300 LPM to 1,000 LPM. For example, the dp/p-4100 prints at 600 LPM, the dp/p-4200 prints at 300 LPM, and the dp/p-4300 prints at 1,000 LPM.

SUMMARY OF CHARACTERISTICS

The dp/p-4000 Series LINE/PRINTERS are characterized by design simplicity which gives high reliability at low cost. Operation is very easy. Knobs and adjustments are conspicuously absent. Ribbon change takes less than one minute. The operator can quickly and easily load paper by swinging forward the drum gate. Preventive maintenance is straightforward, quick and inexpensive.

High reliability of the printers owes much to the unique hammer design. The print hammer is a single moving part. All friction points and adjustment devices have been eliminated. There are no cams, toggles, levers or latches.

The print drum is a continuously rotating hard-surfaced cylinder mounted on a steel mandrel. Its exact position is continuously monitored and indicated electrically by a digital code. This drum is engraved with 132 identical sets of 64 characters.

Printing of the characters is governed by the timing of the hammer fired at each of the 132 print positions.

The paper drive system uses two pairs of tractors arranged so that paper loading, unloading, and adjustment is simple and quick.

Electronics are all solid-state, plug-in modules.

The printers are buffered. Flexible interfacing allows direct connection to most present-day computing equipment.

SPECIFIC ADVANTAGES

- High reliability
- Design simplicity
- Easy operation
- Fast and convenient paper loading
- Straightforward, inexpensive preventive maintenance
- Flexible interfacing
- Unique hammer design, no adjustments needed
- Easily accessible forms tractors for paper loading
- Quick ribbon change, standard tabulating machine type
- Total cost economy

THE 4000 SERIES LINE/PRINTERS

Figure 1 is an overall view of a LINE/PRINTER of the series showing the two major assemblies; the printer chassis and the electronics gate. On the printer chassis is a paper feed mechanism, drum gate assembly, a hammer bank assembly, a control panel, and power sequencing relays. The electronics gate contains power supplies and card-cage assemblies.

In the print system, print paper is fed vertically between a print drum and a hammer bank. An inked ribbon is fed horizontally between the paper and the print drum. Printing is by hammers striking the paper and ribbon against characters on the rotating print drum. The drum's rotation causes 64 different characters, etched on the surface of the drum in skewed rows of 132 each, to pass a bank of 132 print hammers.

On a command to print a given character, the selected print hammer impacts the paper and ribbon against that character on the print drum as it passes the print position.

The print system consists of the drum gate assembly which houses the drum itself, a character-code timing wheel, a character-code zero reference, and a ribbon feed assembly which moves the ribbon diagonally across the face of the character drum. The print system also includes the hammer bank assembly mounted on the top of the printer chassis directly opposite to the character drum.

The paper is fed between the print drum and the hammer bank by a paper feed system which consists of an assembly mounted on the printer chassis base. Four pin-feed tractors physically support the paper and move it between the drum gate and the hammer bank.

A control panel assembly is mounted to a rigid frame on the left of the printer chassis. This panel contains operating switches and indicators.

The electronics gate contains power supplies in its lower half and card cage assemblies in its upper part. The cages provide mechanical mounting and electrical interconnections for the printed circuit logic cards. Character data and command signals are accepted from a data source. Sequential characters are stored in a buffer which accepts one complete line at a time. The entire data output from the buffer is sequentially compared with the code of the character line passing the hammer bank, and is restored in the buffer. Each time a match occurs, a signal is sent to the proper hammer driver. The hammer driver pulses its hammer and causes the drum character to be printed at the selected position. This sequence is repeated for each set of characters on the drum until all the data in the buffer, that is the complete line, has been printed. The paper is advanced while the buffer is reloaded from the data source for the printing of the next line of data.

THE HAMMER ASSEMBLY

The print hammers of the LINE/PRINTER series are housed in a hammer bank assembly which is hinged as two sections to allow easy access. An armature winding is an integral part of each hammer. It floats between the pole pieces of a permanent magnet. Actuation of the hammer by a current flowing in the armature drives the hammer toward the character drum. This hammer movement drives the paper, and in turn the ribbon, against the selected drum character.

The hammer then rebounds from the impact and comes to rest against the back stop. The hammer mounting springs provide support and alignment for the hammer. These springs are also electrical lead-ins for the armature winding. They are coated with a damping material to limit high frequency hammer oscillations.

The way in which the paper is impacted onto the ribbon and the print drum is of great importance in reliably achieving high quality printed characters. The drum itself rotates at a constant speed so that the characters on its surface are carried past the print position. When a selected character is approaching the print position and is a known time away from that position, the appropriate hammer is energized and must travel from its rest position to impact during the same time interval. Any error in travel time will produce a registration error. A registration error exceeding 0.005 inches is usually noticeable. Since people are used to seeing printing lined up accurately in horizontal lines, this error becomes objectionable when adjacent characters have maximum plus and minus vertical errors. Chain printers overcome this problem since their registration errors lie along the line, and people are used to horizontal irregularities in type spacing and do not find them objectionable. The Data Products Corporation LINE/PRINTERS in the 4000 Series overcome the problem by maintaining vertical registration to within ± 0.010 inches for at least 1000 hours without adjustments.

Paper and ribbon are resilient. So when the hammer strikes the paper and ribbon onto the character face, they behave as a spring whose stiffness is a function of the character area, type of ribbon, type of paper, number of copies being made, and the peak force developed during impact. The stiffness, as a function of the peak force, is fairly constant until the force becomes large enough to crush the paper fibers. Beyond this level the stiffness increases rapidly until further increases in the force leads to penetration of the paper. Optimum printing takes place at a hammer force short of the paper crushing force. For best results, the peak force must stay within 70 to 90% of the paper crushing force. Careful control of the print force not only preserves high print quality but also extends drum and ribbon life.

The design of the 4000 Series LINE PRINTERS permits a 20% variation in force so that satisfactory print quality is obtained for either one printed copy or six-part copies without needing a penetration control adjustment. Penetration control is avoided by the hammer design which allows accurate control of the energy imparted to the hammer during the print process.

The hammer bank is shown in Figure 2. A single hammer is shown in Figure 3. The shank of the hammer is made of hard-coated aluminum and is shaped so that the attachment section for flexible pivots is out of the path of the stress wave which travels longitudinally along the shank at impact. As mentioned earlier, the pivoting members are coated with an elastometric damping material. Since rotational movements at impact could produce buckling forces on the pivots, the hammer structure is very carefully balanced to prevent these moments from developing.

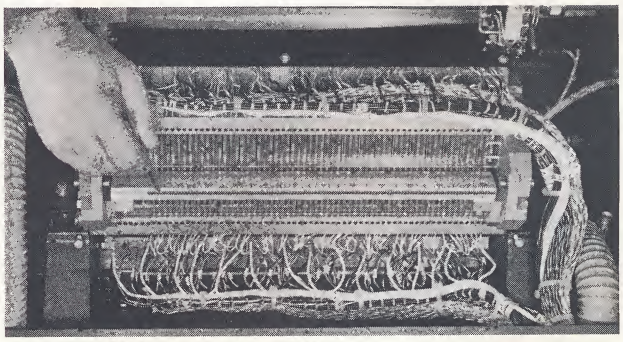


Figure 2 — LINE/PRINTER Hammer Bank

In the shank is a slot for the coil assembly and a channel to carry the wires to the coil. The coil assembly consists of a flat coil containing a relatively large number of turns of aluminum ribbon of rectangular cross section, two flat aluminum side pieces, and a spacer. The side plates mechanically support the assembly and provide an excellent thermal conducting path to the exterior through which heat generated in the coil can be transmitted. Each turn of the coil has a very short heat conducting path through the spacer to the aluminum skin. In addition, the shank itself acts as a heat sink since the thermal conductivity between coil assembly and shank is high.

The pivot tube is shaped so that it can be accurately registered with respect to the flex pivots and the locating 'V' into which it fits. Thus, coil-to-magnet and hammer center-to-center spacings are accurately maintained.

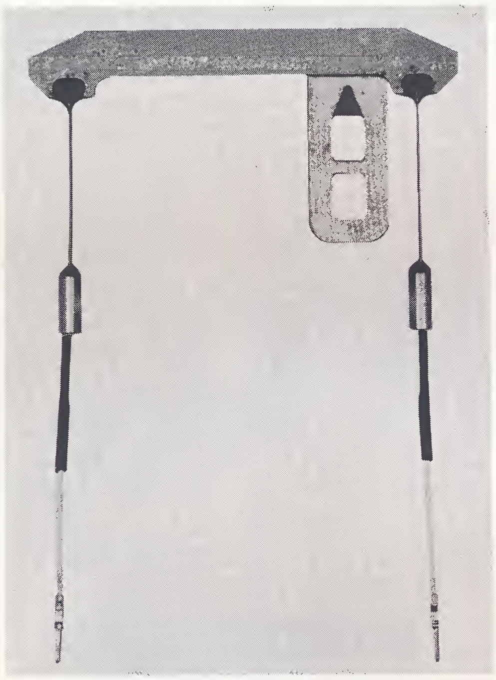


Figure 3 — Single Hammer

The entire hammer structure is given mechanical strength by joining all elements with shock proof structural epoxy. A three ampere, 2 millisecond current pulse conducted to the coil through the flexible pivots produces a forward magnetic field thrust which causes the hammer to accelerate at a nearly constant rate over a 0.1 inch stroke. The travel time of the hammer is set by a locating screw behind a backstop. This screw takes care of an initial ±8% variation in the magnet strength and minor differences in hammer weight and pivot stiffness. Only rarely is it necessary to change the setting of this screw after replacing a hammer since the screw's major function is to compensate for variations in magnetic field strength, and this is not changed when a hammer is replaced.

Each hammer is held in place by two screws: one in front and the other at the rear of the holding plate. A connection to the driver circuit is through taper pin connectors at the end wires which are welded to the hammer flex supports.

The replacement of a hammer is a simple two-minute job. The four screws which fasten together the upper and lower halves of the hammer bank assembly are loosened. The upper half of the assembly is swung back on its hinges. The two hammer locking screws are loosened, taper pins withdrawn, and the hammer removed. The replacement hammer is dropped in place. The two screws are tightened. The taper pins are plugged in, and the assembly is closed and secured.

The hammer bank is maintained in a positive pressure atmosphere of filtered air. This prevents the entrance of dust and also aids in cooling the hammer bank. Long-term reliability is thereby enhanced.

PRINT DRUM

The print drum is a beryllium copper sleeve on which the print characters are photoetched. The sleeve is expanded by heat and slid onto a heavy steel mandrel to which it becomes rigidly attached when cool. This combined mandrel and sleeve forms the character drum assembly which is mounted on bearings and geared to the drum motor.

The characters on the drum are skewed column to column, so that when the drum is rotating at its operating speed of 640 rpm*, the same character in each succeeding column arrives at the print position 8 microseconds later. (See Figure 4.)

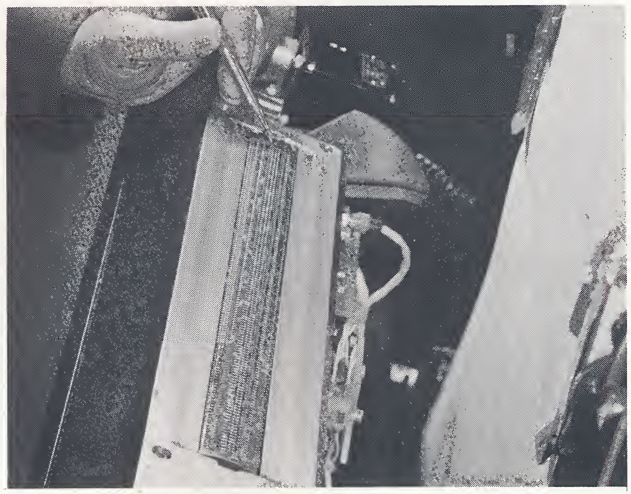


Figure 4 — Print Drum Showing Skewed Columns

*360 rpm for the 300 LPM model, and 1000 rpm for the 1000 LPM model.

Factors taken into account in the design of the print drum are the initial clarity of the etched characters, the rockwell hardness and resultant ability to withstand repetitive printing without degradation of the character quality, the amount of momentum that can be stored in the character drum assembly to prevent velocity changes during the print operation, and the stiffness of the motor assembly that drives the drum.

A character code zero reference is mounted at the right end of the character drum mandrel (Figure 5). A character code timing wheel is mounted at the left end of the mandrel. These ensure that the print hammers impact the selected characters at the right time.

The character code zero reference is a pin of high-mu metal inserted in the mandrel. It is sensed once each revolution by a variable reluctance pick-off which issues a once-per-revolution reset pulse. This pulse ensures that a counter accumulator is in its zero or cleared position at the beginning of each revolution of the drum. The counter accepts pulses from the character code timing wheel. This wheel consists of a gear which is positioned relative to the drum so that column one characters have a one-to-one correspondence with the valleys of the gear. A variable reluctance pick-off senses the valleys. This is a decided advantage over machines which use a variable reluctance pick-off system sensing the actual teeth. The sensing of a null output at the valleys gives a basic method of determining which character is in the print postion.

The once-each-character pulses enter the counter to advance its accumulator until 63 is reached. It is then returned to zero on the 64th count. The clear pulse from the character code zero reference comes through to make sure that the counter is returned to zero before the start of the next print cycle. It is important to note that the timing of the code zero reference is not critical. Hence, the Data Products 4000 Series LINE/PRINTER drum is really free of fiducial marks; a decided advantage.

The once-per-character variable reluctance pick-off can be moved relative to the timing gear through plus or minus one character. Characters can thus be phased for best print quality. The timing pulse is also fed through a univibrator chain. A potentiometer is used to set the timing pulse accurately relative to the drum motion.

Special drums are available as options. These drums are of the style, font, and symbol sequence as specified by the customer, provided they satisfy the dimensions and land widths of:

Character Size:	0.095″ ± 0.003″	High
	0.065″ ± 0.003″	Wide
Land Size:	0.008″ ± 0.001″	Wide
Character Spacing:	0.100″ ± 0.005″	Centers
Symbols per Column:	to 64 maximum	

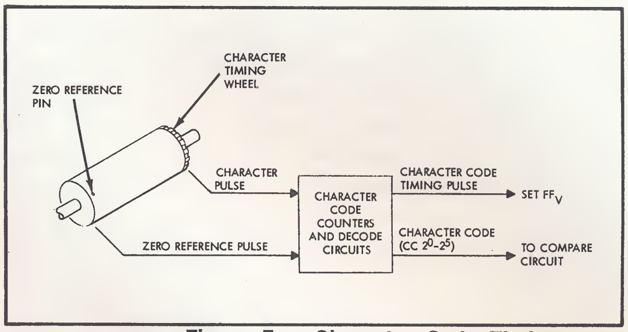


Figure 5 — Character Code Timing

RIBBON

A one-inch tabulator-type ribbon is used in the 4000 Series LINE/PRINTERS. It consists of 18 yards of a heavy silk webbing impregnated with ink. It is loaded onto the printer with greater ease than a ribbon can be replaced on a standard typewriter. The ribbon assembly automatically establishes the position of the ribbon relative to the character drum. The ribbon traverses the drum gate in a skewed fashion (Figure 6) so that column 132 is printed by the lower edge of the ribbon. The other columns print in sequence across the ribbon's width. Thus, the whole of the ribbon's surface is used for printing, and maximum ribbon life is obtained.

The ribbon automatically reverses its direction of travel across the print position when an eyelet close to each end is sensed. During operation the ribbon is normally held stationary by two opposing torques from take-up spools. These torques tension the ribbon the desired amount. As paper is advanced for the next print line, an additional winding in one of the ribbon drive motors is energized. The torque of this motor exceeds that of the other, and the ribbon is shifted slightly to bring a fresh area into the print position. When the end eyelet is sensed, the ribbon motion current is transferred to the secondary winding of the opposite torque motor, and so on.

The printer unit will clearly print up to six standard interleaved copies.

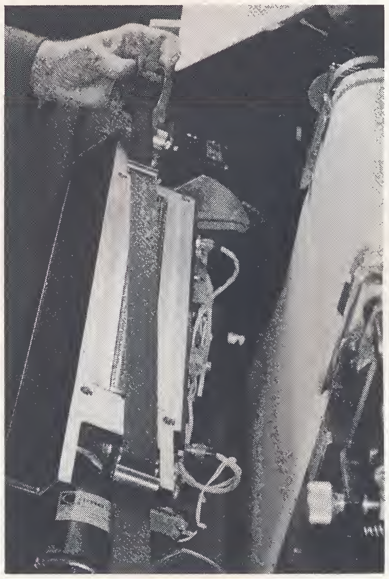


Figure 6 — Path of Ribbon

PAPER DRIVE MECHANISM

To maintain high print quantity not only must the character generating drum and the hammers be of precision manufacture and operation but also the paper must be manipulated so that these precise components can be fully utilized. A paper drive mechanism holds the paper stationary during the printing of the line, and then rapidly moves and precisely locates the paper for the printing of the next line. Accuracy of the stop position for each line is within 0.008 inches for at least 1000 operating hours.

The paper drive mechanism of a LINE/PRINTER of the series is shown in Figure 7. The paper is carried by two pairs of tractors (Figure 8) which are adjustable by verniers. These tractors are driven by a rotary digital motor which has a feedback of motor position.

Each pair of the adjustable tractors can be positioned to feed various paper widths. The paper is given its correct tension in the horizontal direction by adjusting the tractor verniers. Vertical paper tension is adjusted by a vertical tension control knob. This knob swings a rocker assembly through a slight arc to change the length of the belt paths from the upper and lower tractor shafts to the drive motor. The upper tractor shaft is thus made to rotate with respect to the lower, and the paper tension is changed as a result of this rotation.

A horizontal adjustment provides a plus or minus one column shift by moving the upper and lower tractors' support shaft to the left or right. This is done by screwing a pair of threaded rods which are anchored by their mounting brackets against the shaft, thus driving the tractors. Coupling belts make sure that the tractors move together in this left/right adjustment. Control is by a single knob.

Paper may also be moved through a vertical adjustment of plus or minus one-quarter inch by rotating the motor mount assembly. The rotor of the motor is magnetically locked to the frame. Hence, when the frame is rotated, the rotor turns also and moves the paper with both sets of tractors together.

The tractor assemblies also contain sensors which warn of paper breaks and end of paper supply.

Paper must be held rigid while printing occurs, as the rotation of the drum tends to pull the paper. The required rapid acceleration and deceleration of the paper must be accurately controlled by the feed mechanism so that energy transferred to the paper web maintains the correct tension but does not shear or wrinkle the web. Tractors, tractor shafts and pulleys have all been proved in the line printer industry. Selecting the motor to drive them is an important reliability design factor. In the LINE/PRINTERS, a digital paper drive motor was selected to produce highly reliable operation of the drive system.

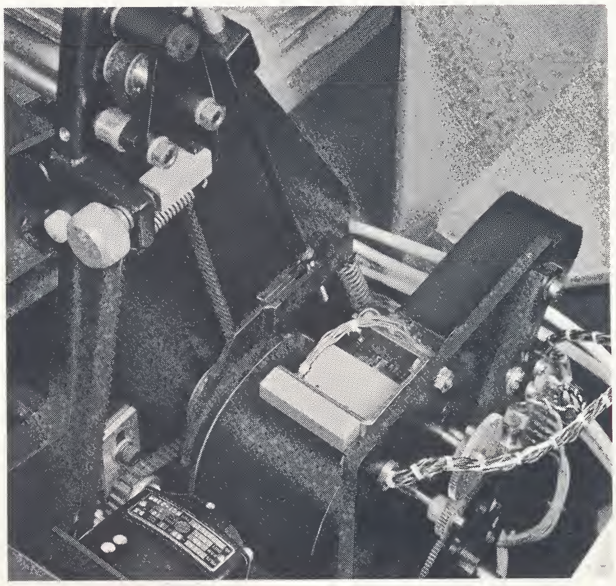


Figure 7 — Paper Drive Mechanism

The rotary digital motor used in the drive system has a position sensor. It makes use of technologies which were developed for guidance systems and for other searching, homing and latching operations. It is analogous to a precision servomotor containing both a positioning stator and a torque stator. The permanent magnet rotor, supported on two precision ball bearings, is surrounded by a stator field winding which establishes either the holding force lock or the turning force torque on the rotor, depending upon how the windings are energized.

The position sensor is used as a pickoff stator, feeding back to the servo loop electronic signals to control the torque generating currents that are applied to the torque stator.

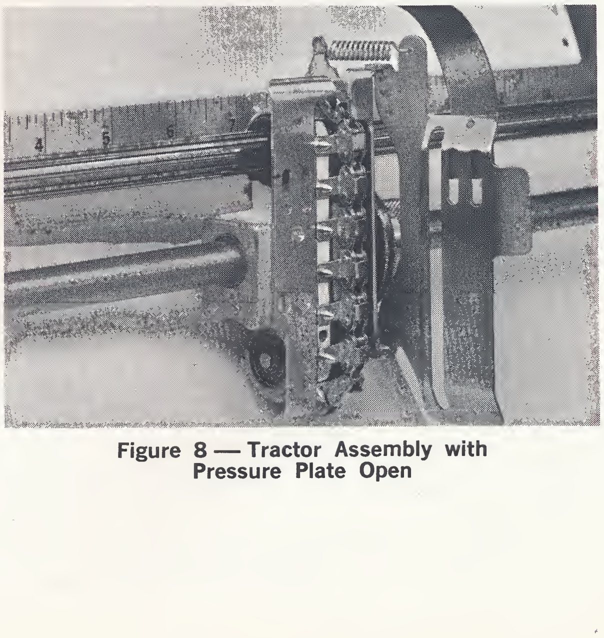


Figure 8 — Tractor Assembly with Pressure Plate Open

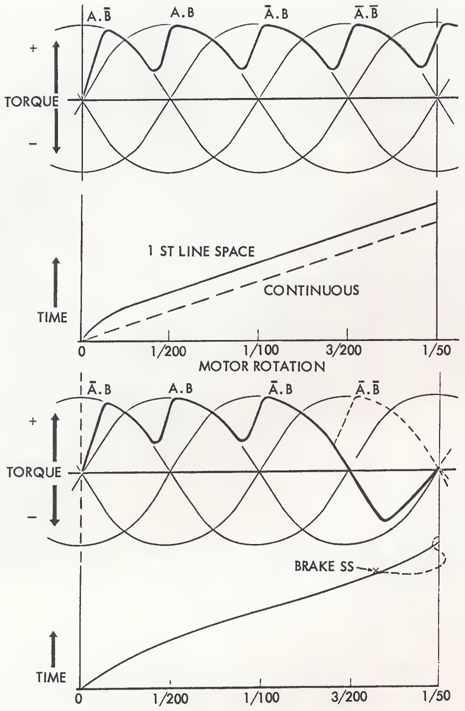


Figure 9 — Static and Dynamic Characteristics of Paper Drive Motor

Figure 9 shows the static and dynamic characteristics of this motor. The field winding can be energized in any of four different patterns, each of which causes the rotor to reflect a torque position curve approximating a sine wave. The phase of this curve can be servo shifted in 90 degree increments by switching to the appropriate field pattern. The rotor will home or lock on any of the negative slope crossover points for any of these four patterns. In this condition, it behaves like a stiff spring with stiffness equal to the crossover slope. Crossover slopes have been chosen to prevent searching.

The paper motion and control circuitry steps the windings of the drive motor through the logical sequence for moving the paper. When a LINE/PRINTER receives the paper instruction, a current is applied to the first phase of the motor thus giving it a maximum forward torque. As current is maintained in this wiring, and the motor begins to rotate, the point of zero torque for that phase is reached. The crossover point is detected and current is then switched to the next phase, again applying full forward torque. Again a crossover point is detected and current is switched to give maximum forward torque. At this point a velocity reference is taken by comparing the marker pulses to a one-shot univibrator. The feedback signal derived from this comparison switches the current at this time back to phase two of the motor. The motor goes into reverse torque and braking is achieved. A crossover is again sensed and current is switched to that winding which gives maximum reverse torque. The motor stops completely.

The above features of the motor make it behave as a clutch; giving start, run, brake, stop, detent, but without the troubles of mechanical clutch systems. Full advantage of these clutching features is taken by switching the field windings at the correct time. This is done by sensing the rotor position and automatically selecting the correct sequence of field patterns to yield the required torque position.

Positioning accuracy of the paper drive is inherent in the motor. Hence, the number of start-stop cycles does not change positional accuracy. All elements in the system including motor, pulley, bearings, shafts and belt are derated to operate at one-quarter to one-half the normal commercially-rated levels. For example, the motor itself operates at 50% of its rating. Thus, the lifetime of all components is greatly improved.

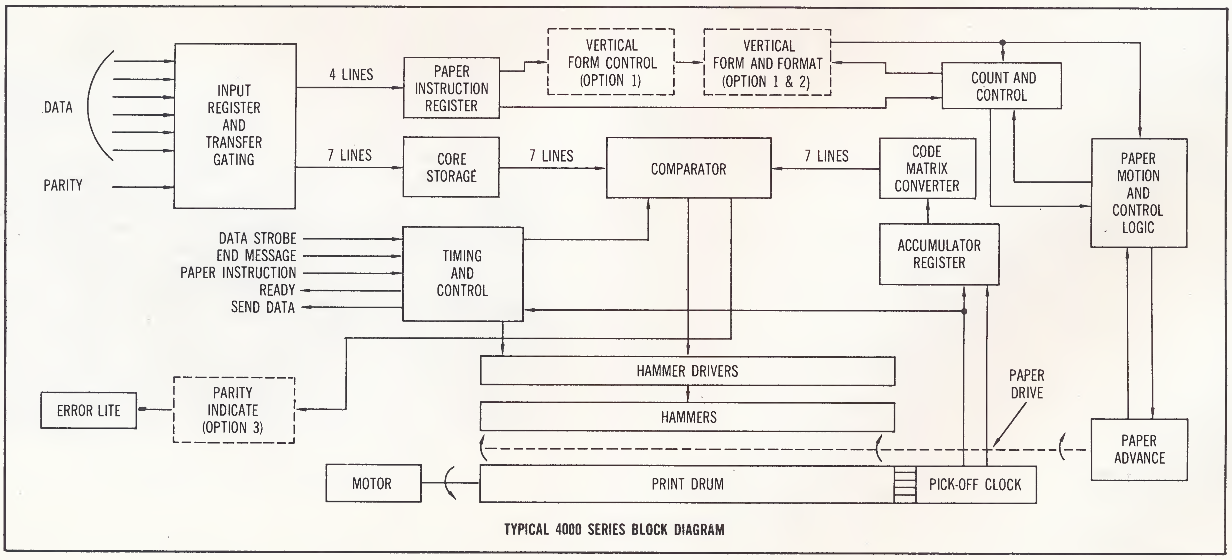


Figure 10 — Block Diagram of 4000 Series LINE/PRINTER Electronics

ELECTRONICS

A block diagram of the 4000 Series LINE/PRINTER electronics is shown in Figure 10. Solid blocks show basic electronic functions. Dotted blocks show the options that can be added to a basic printer.

All electronics within a LINE/PRINTER are solid-state pluggable modules. The logic within the system is straightforward with a minimum of closed-loop circuitry. Voltage and current levels are designed sufficiently low for high reliability to be improved by derating components. Wherever possible, all electronic circuits are on plug-in replaceable boards. These boards are readily accessible because of their mounting on the electronics gate which pivots from the cabinet.

A typical example of the type of reliable circuit board used throughout the electronics is the hammer driver board. The basic function of this board is to accept the low-level, short duration signal from the buffer output logic and use it to control the high-level long duration signal needed to drive the hammer.

The driver is basically an amplifier, latch, integrator, and a current driver. The shape of the output signal (Figure 11) gives clear, consistent printing. A relatively slow rise prevents generation of high frequency energy which might be reflected back into the system or radiated as electromagnetic interference. The impedance of the lines being driven by the output stage is intentionally low to prevent radiation, but the lengths of wire required is sufficient to radiate energy from high current pulses. The slow rise time keeps this radiation low.

The level to which the signal rises controls the impact energy of the hammer and hence the print density. A feedback control maintains consistent character densities despite the different areas of the characters to be printed. Signals from the code wheel are interpreted as high or low area characters and the drive signal output is adjusted accordingly.

Current is maintained in the hammer wiring after impact by having a slow decay time for the drive pulse. This current slows the rebound of the hammer. The rebound energy is thus reduced and thereby leads to a low energy of impact with the backstop. In turn this produces quick recovery of the hammer at rest for the next print cycle.

TIMING

As each skewed row of characters on the character drum reaches the print position, the character pulse is generated. Each character pulse starts a character-scan cycle which consists of sequentially comparing the contents of each address with the row of characters in the printing position. Each of the individual address comparisons is referred to as a character scan. Space codes and non-print code combinations have their sentinel bit written to zero on first scan through memory. A sentinel bit is written to a one in an eighth plane of the memory as each character is loaded.

When a match occurs during an individual character scan, the buffer character being compared is printed at the line position corresponding to the scanned address. The sentinel bit accompanying each unprinted buffer character is written to zero. Unmatched buffer characters retain their sentinel bits until matched and printed during some subsequent character scan cycle.

These steps are repeated until a character scan cycle which does not produce sentinel bits is completed. This indicates that all buffered characters have been printed. Immediately after the last character-scan cycle, regardless of the amount of character-drum rotation since the *end-of-line* signal, the *send data* signal becomes true.

Low usage characters can be grouped together on the print drum. When the low usage characters are not employed, the paper can be advanced as these characters are passing the hammer bank and a higher continuous use rate can be maintained. The paper feed advances the paper one line space in a maximum time of 30 milliseconds.* When the paper has to be advanced more than one line with a single paper feed instruction, the paper speed stabilizes at 20 inches per second. This is equivalent to about 8½ milliseconds per line.

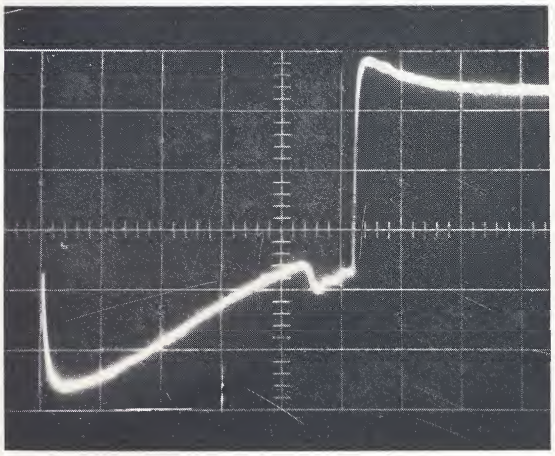


Figure 11 — Hammer Drive Signal

INTERFACE

The interface between the data source and the Series 4000 LINE/PRINTER consists of ten receiver lines and four transmitter lines. Signal levels presented to the interface are as follows:

True = "1" = −5 volts
False = "0" = +5 volts

Conventional current from the interface when the signal is positive is 15 milliamps. Conventional current to the interface when the signal is negative is 1 milliamp. Rise and decay times at the interface are 0.5 microseconds maximum.

*20 milliseconds for the 1000 LPM model.

The ten receiver lines consist of six data lines, a parity line, a character strobe line, a paper motion line, an end-of-line line and strobe line.

The four transmitter lines are for ready signal, send data signal, space complete signal, and parity error signal when the parity check option is used.

The options available to the interface include a level shift to change logic levels, parity check, code conversion diode matrix, vertical format and horizontal format controls.

MAINTENANCE PANELS

Maintenance control panels are available in two options. Option 1 includes voltage margin switches to permit all dc voltages to be set at $\pm 5\%$ of nominal. Option 2 provides for comprehensive testing of the printer without employing the data source.

The maintenance panels are fully described in the next Section.

OPERATIONAL CHARACTERISTICS

CONTROL PANEL

All the controls for operating a Series 4000 LINE/PRINTER are on one panel as shown in Figure 12. The POWER ON switch controls the main power to the printer, ac to the blowers and the drum motors and the dc power supplies. Sequencing relays control the sequence of power application to the various subassemblies.

The END OF PAPER light indicates when the LINE/PRINTER is on its last form or when the paper becomes torn.

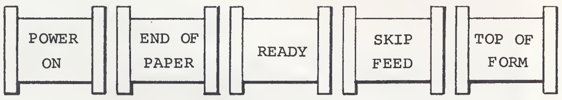


Figure 12 — Control Panel Switches

The READY switch enables the *send data line* which tells the data source that the LINE/PRINTER is ready to print.

The SKIP FEED switch slews the paper as long as the switch is depressed.

The TOP OF FORM switch advances the paper to the top of the form position.

All switches are push switches which are lit in the ON position.

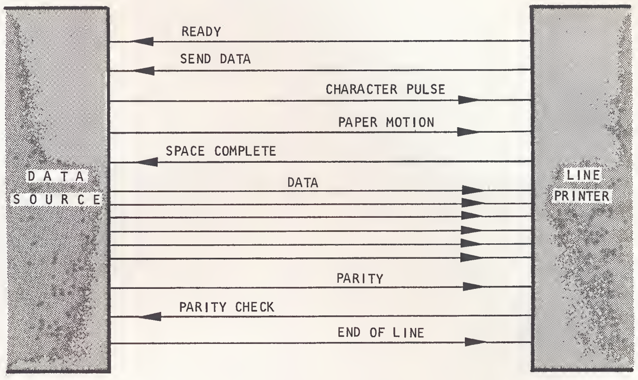


Figure 13 — Interface Lines and Sequencing

SEQUENCE OF ELECTRONIC FUNCTIONS

The sequence of the electronic functions of a Series 4000 LINE/PRINTER and the types of signals between the data source and the printer are now described. (See Figure 13.)

The electronic functions start with the transmittal of the *printer ready* signal to the data source. This signal informs the data source that the interface is opened and information for printing can be accepted by the printer. A *send data* signal requests the information from the data source. When a character is presented on the *input data lines* accompanied by its strobe pulse on the *character pulse line,* the *send data line* goes to its false state and remains there until the input cycle has been completed. which is approximately 8 microseconds.

A *paper instruction line* controls paper motion if the vertical format option is not used.

When a vertical format is used, the following applies. If this line is true at the time when the data strobe becomes true, the information on the *data line* is not loaded into memory but is transferred to a paper instruction register since the data are paper motion instructions. If the *paper instruction line* is in false state, the data on the *data lines* are sequentially loaded into a core memory of 132 positions since the data are print data. There are two options which allow this print data to be loaded in random fashion, but under normal circumstances data is sequentially loaded through the 132 positions. The loading of the last position of core memory corresponding to the last column of printing, may be detected and signalled to the data source to tell it that the entire memory has been filled.

When a line of data has been loaded into the memory, the data source gives a print instruction or an *end of line* instruction. On receiving this instruction, the LINE/PRINTER changes the state of the *send data line* to false, thus telling the data source that further data will not be accepted. The paper motion control is interrogated to make sure that the paper instruction has been completed and that the paper is stationary ready to accept printing. Printing can now begin.

First, the character code of the next character to be in a printing position is presented to a comparison circuit through an encode/decode matrix. The character in position one of the core memory is taken from memory and compared with the first character coming into the print position and also with the various space codes or inhibit codes. If a match is found between the space code or inhibit code, a marker bit which exists in the eighth plane of the core memory is written to zero. No printing occurs at that print position. If, however, a match is found between the character approaching print position and the character in core memory, the appropriate hammer circuits are triggered and the character is printed when it reaches the print position.

The character in core memory position number two is next interrogated and it is printed if a match is found. The process is repeated through the total 132 positions. On this first pass through memory, the sentinel bits on all those characters that are printed are written to zero. All space codes and illegitimate codes have their marker bit also written to zero.

This sequence is now repeated for the next succeeding character coming into the print position. It continues to be repeated until there are no longer any sentinel bits in the eighth plane. It is significant in the design of the 4000 Series LINE/PRINTERS that the character drum does not necessarily have to complete a whole revolution for the printing of a line. Printing is completed when all marker bits have been returned to zero. The LINE/PRINTER is then ready to accept a further line of data.

The 8 microsecond displacement between a character in any one column and the same character in the next column is the time needed to extract a character from core memory, to compare it, and to restore it to core memory. Thus the physical skew of the characters on the drum is an important factor in determining the effective speed of a LINE/PRINTER. A drum designed for 300 lines per minute operation cannot be used at 600 lines per minute. Drums have to be changed to increase the speed.

The technique for deriving individual character codes from the accumulator register is for the twelve lines of the accumulator register to be fed through a diode encode/decode matrix by which they are expanded to 64 lines. These 64 lines are then decoded down through an additional diode matrix to establish any specific character code required by the user. It is at this point that parity is inserted with the character if this option has been selected by the user. Parity may be either odd or even and is generated in the diode matrix. Parity cannot be checked in a machine that does not have the code conversion option.

INTERFACE SIGNALS

SEND DATA This signal from the LINE/PRINTER is true to indicate that the printer is ready to receive new information for printing or to feed paper. As each character is strobed into the printer, this line becomes false and stays so until the printer is ready for the next character.

CHARACTER PULSE This signal from the data source strobes character or paper feed information on the *input data lines* into the printer. This signal is applied to the printer only when the *send data* signal is true, and must be of at least one microsecond duration.

INPUT DATA Six or seven lines transmit character or paper feed information to the printer and must be established with or before the leading edge of character pulse. These lines must remain stable for a minimum of 3 microseconds following the leading edge of the character pulse. The seventh line carries a parity bit used to check parity.

END OF LINE This signal to the printer is transmitted after the last character to be printed on a line has become true. The signal can become true any time after the *send data line* becomes true, and need only remain true for 4 microseconds.

PAPER INSTRUCTION With vertical format control this signal to the printer indicates a paper instruction is to be provided on the *data lines*. The *paper instruction line* must be true concurrently with the *character pulse line*.

PRINTER READY This signal from the printer is true when the printer is in an operable condition.

Parity Error This line to the data source goes true when some of the data on the *data lines* is invalid. The signal indicates that at least one character was wrong.

Paper Count A pulse on this line when a paper instruction is present indicates the data on the *data lines* is to be used directly for paper spacing rather than for tape controlled paper movement.

OPTIONS

The following options are available for the 4000 Series LINE/PRINTERS:

Level Shift: Cards are available to interface with the following common logic levels or their complements:

0 and −6 volts
0 and +10 volts
0 and −3 volts
0 and −10 volts

Parity Check: Parity Indicate. Accepts the seventh data line bit as a parity bit. When a match exists between the six data bits of the drum code and the stored character code, the seventh bits are compared. A signal is delivered to the interface on the *parity error line* if an error is detected.

Parity Clear and Indicate. Parity error is detected and indicated as in Parity Indicate but the print operation is stopped without the character in error being printed. Only the character in error is not printed. If the computer is so programmed, it may retransmit the line *without* a paper instruction, and overprint the line to pick up the unprinted character. The overprinting of the previously printed characters, i.e., up to the one in error, is registered and only shows a deeper intensity of print.

Code Conversion: Printed circuit diode matrixes decode information in the code accumulator. The count is converted to a specific information code and selection of odd or even parity is through the matrix. Different sets of matrix boards may be inserted to change codes without changing drums.

Vertical Format: Paper Tape Format Control. This option controls vertical spacing by a stored program on punched paper tape. An 8-channel paper tape reader is mechanically coupled to the paper transport motor so that one character punch position on the tape corresponds with one line space (1/6-inch) of paper travel (Figure 14). A paper instruction character is used as an address instruction to the paper tape reader. The paper instruction character appears on the *data lines* in conjunction with a true signal on the *paper instruction line*.

The three low order bits of the paper instruction present a binary count corresponding to the paper tape channel to be read. The paper advances automatically until a hole is sensed in the selected channel. Timing of the paper instruction character is identical to that of a data character.

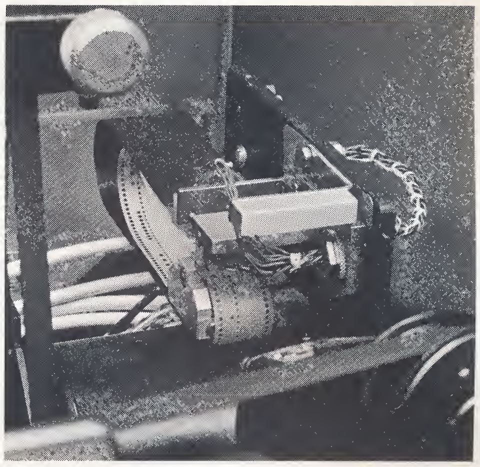


Figure 14 — Tape Format Control Assembly

One Through Seven Format Control. This option, in conjunction with the Paper Tape Format Control, provides internal detectors and counters to respond as follows:

001001	Space 1 line
001010	Space 2 lines
001011	Space 3 lines
001100	Space 4 lines
001101	Space 5 lines
001110	Space 6 lines
001111	Space 7 lines

One through seven can only be selected in association with punched paper tape format control. If both these vertical format controls are used the operator control panel of a LINE/PRINTER is changed to permit *skip feed* to operate as *top of form.*

Horizontal Format: Random Address. The buffer address lines are presented to the interface to permit random access during the load cycle. The address counter remains operative, with jam transfer permitted to the buffer. If horizontal skip is desired, the column binary count of the next print character is presented to the address lines accompanied by an address strobe after the *send data line* has gone true. Data is not presented at this time. The *send data line* then goes false and remains in that state for 4 microseconds. When the *send data line* changes to true, the data for that character position is presented. Additional data presentations are sequentially positioned from that point until another transfer or an *end-of-line* signal occurs. There are no restrictions to the number or sequence of transfers except those stated.

Tab Address. This option includes a plugboard which contains up to five core memory addresses. Activation of the *tab line* addresses the core during the load operation to the preset addresses sequentially. The same timing restrictions apply as those for Random Address.

MAINTENANCE

Maintenance of the 4000 Series LINE/PRINTERS is straight-forward. The accessible card-cages are shown in Figure 15. Circuits are referred to by card location and circuit numbers; for example, C14-400 refers to card cage C, receptacle 14, circuit 400. The design allows measurements to be made at the card receptacle pins without removing the cards. A card extender allows measurements to be made within the cards.

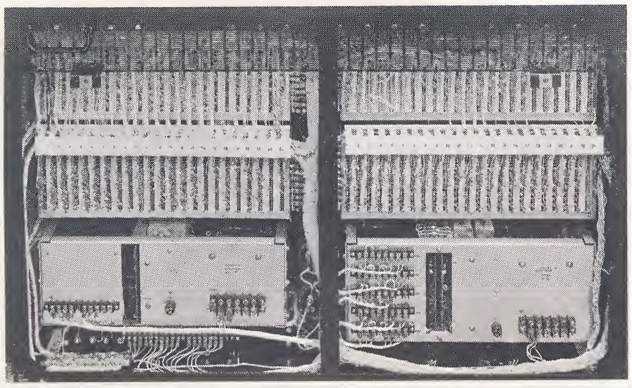


Figure 15 — Electronics Gate Showing Easy Accessibility of Electronics

Two maintenance panels are available as options, a voltage monitoring panel and a maintenance panel.

The voltage monitoring panel is shown in Figure 16. It allows testing of the printer under conditions of ±5% preset high or low voltage supply. Each marginal check switch can change the corresponding power supply output to a value that is ±5% normal. A voltage select switch selects the voltage displayed by the meter.

The maintenance panel is shown in Figure 17. It allows comprehensive testing of the printer without having to use the input equipment of a data source. Push-button indicator switches manually control the character counter, memory register, address register, paper control register, and all flip-flops. Lever switches select a sync signal that coincides with any particular address of character count.

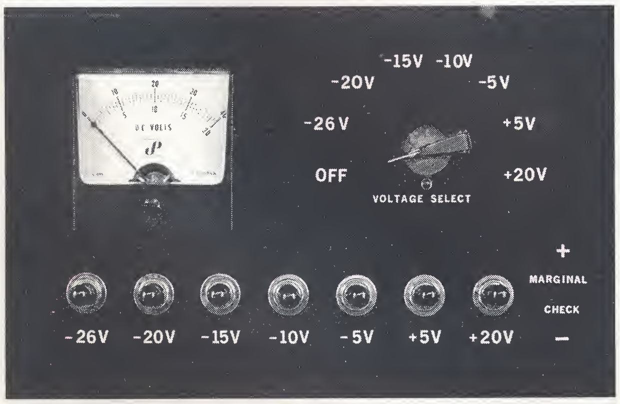


Figure 16 — Voltage Monitoring Panel

The following is a listing of the maintenance panel controls and their functions.

CHARACTER COUNTER:

(2^0 through 2^5 and CLEAR)

Used to set the character counter to a count corresponding to a particular line on the drum (CLOCK INHIBIT must be up). Count is entered in binary number corresponding to position of line on the drum, however, indication will represent input character code for which the printer is wired. These controls can therefore be used to check the encoding

MEMORY REGISTER:

(2^0 through 2^5 and CLEAR)

Used to enter data into memory register

ADDRESS REGISTER:

(2^0 through 2^7 and CLEAR)

Used to set address register to memory address

C. REGISTER:

Used to enter command into paper control register

FF_D and FF_E

Flip-flops D and E of counter which generate the timing pulses

FF_R

Ready flip-flop

FF_C

Character flip-flop

FF_V

Virgin flip-flop

FF_S

Flip-flop which indicates that sentinel is still in the memory

FF_{PF}

Paper feed flip-flop

FF_{SNTL}

Sentinel flip-flop

FF_P

Parity error flip-flop

FF_T

Horizontal tab flip-flop

FF_A and FF_B

Paper stepping motor flip-flops

FF_{PA}

Paper advance flip-flop

FF_{PM}

Paper moving flip-flop

ADDRESS SYNC SELECT:

(2^0 through 2^7 CHAR SYNC)

Selects memory address with which sync output coincides. (CHAR SYNC must be up.)

$\left.\begin{array}{l} FF_R \\ \overline{FF_R} \end{array}\right\}$ (lever switch)

Selects sync output for load (FF_R) or unload ($\overline{FF_R}$) operation

MAN CYCLE

Unloads or loads buffer, depending on position of UNLOAD LOAD switch

END LINE

Produces simulated end of line input

INCH

Simulates one clock pulse each time pressed. (CLOCK INHIBIT must be up.)

RECYCLE

Permits one line to be repeatedly printed

PARITY INHIBIT

Inhibits parity check

UNLOAD LOAD

Selects printing (UNLOAD) or loading (LOAD) operation

CLOCK INHIBIT

Inhibits clock so that INCH switch can be used to manually generate clock pulses

PRINT INHIBIT

Inhibits the hammers

ON LINE OFF LINE

Selects test panel or normal data source operation. Must be in OFF LINE position when maintenance panel is used

MASTER CLEAR

Clears all flip-flops, counters, and registers

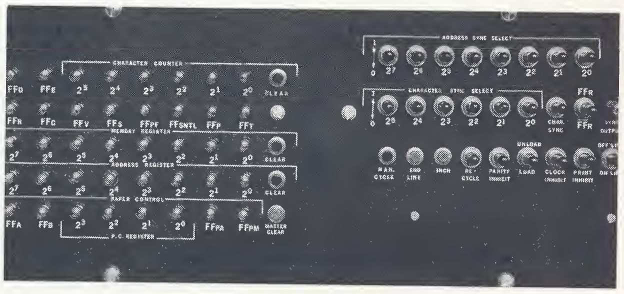


Figure 17 — Maintenance Panel

RIBBON CHANGE

A ribbon can be changed in a few minutes. After switching off the LINE/PRINTER the operator opens the drum gate and pulls the full ribbon spool forward clear of the magnet that holds it. The ribbon is unthreaded from the drum gate and the end is unhooked from the empty spool. The new spool is placed on the ribbon motor shaft so that the ribbon unwinds from the top of the spool. The ribbon is threaded through the two ribbon guides and next to the limit switch actuating foot. About two feet of ribbon is wound onto the empty spool. The drum gate is closed and the LINE/PRINTER is again ready to operate.

DRUM CHANGE

Four drum gate cover screws are removed and the cover taken off. Four more screws are removed to free bearing clamps. The two magnetic pickups are moved clear of the drum and the drum assembly removed. A new drum is installed. The zero reference magnetic pickup is adjusted for 0.003 inch clearance, the timing character pickup is adjusted for the same clearance, the drum gate cover is replaced and a simple adjustment is made to the character timing pickup phasing if needed.

PAPER LOADING

After switching off the printer the operator opens the drum gate and loosens all four tractor clamps. The tractors are then placed so that the left tractors are at zero on the scale and the right tractors are at the width of the paper on the scale. The tractor clamps are then tightened. The paper is placed on the shelf beneath the drum gate and the end of the paper is inserted betwen the drum gate and the hammer bank. The holes in the paper are positioned over the guide teeth on the top two tractors and the pressure plates are closed. The holes in the paper are then positioned over the guide teeth on the bottom tractors and their pressure plates are closed. Next the drum gate is closed and the paper tensions adjusted if necessary.

Horizontal adjustment is made by the fine adjustment controls on the tractor. Vertical adjustment is made by a vertical tension control knob. Vertical and horizontal positioning can be made with the printer running by rotating the appropriate controls.

FORMAT CHANGE

The format for printing forms is rapidly and easily changed by changing the paper tape loop. This is done by raising a handle to clear the sprockets from the nylon roller. The tape loop can then be removed and a new loop inserted so that the hole in channel one (top-of-form hole) is just past the sprocket and the guide holes in the tape are over the guide teeth. Pressing down on the handle clamps the paper tape in the reader.

By pressing the Top-of-Form control, the operator brings the printer into the next top of form position. The operator adjusts the form so that the top is in the print position. He presses the Top-of-Form control again and checks that the paper moves to the next top of form position. If the paper only moves one line the nylon roller of the tape reader must be rotated slightly to make sure that the hole in channel one stops just past the sprocket after a Top-of-Form command has been given; that is, in a direction toward the front of the printer.

HAMMER CHANGE

The ease of hammer change was described earlier on Page 6.

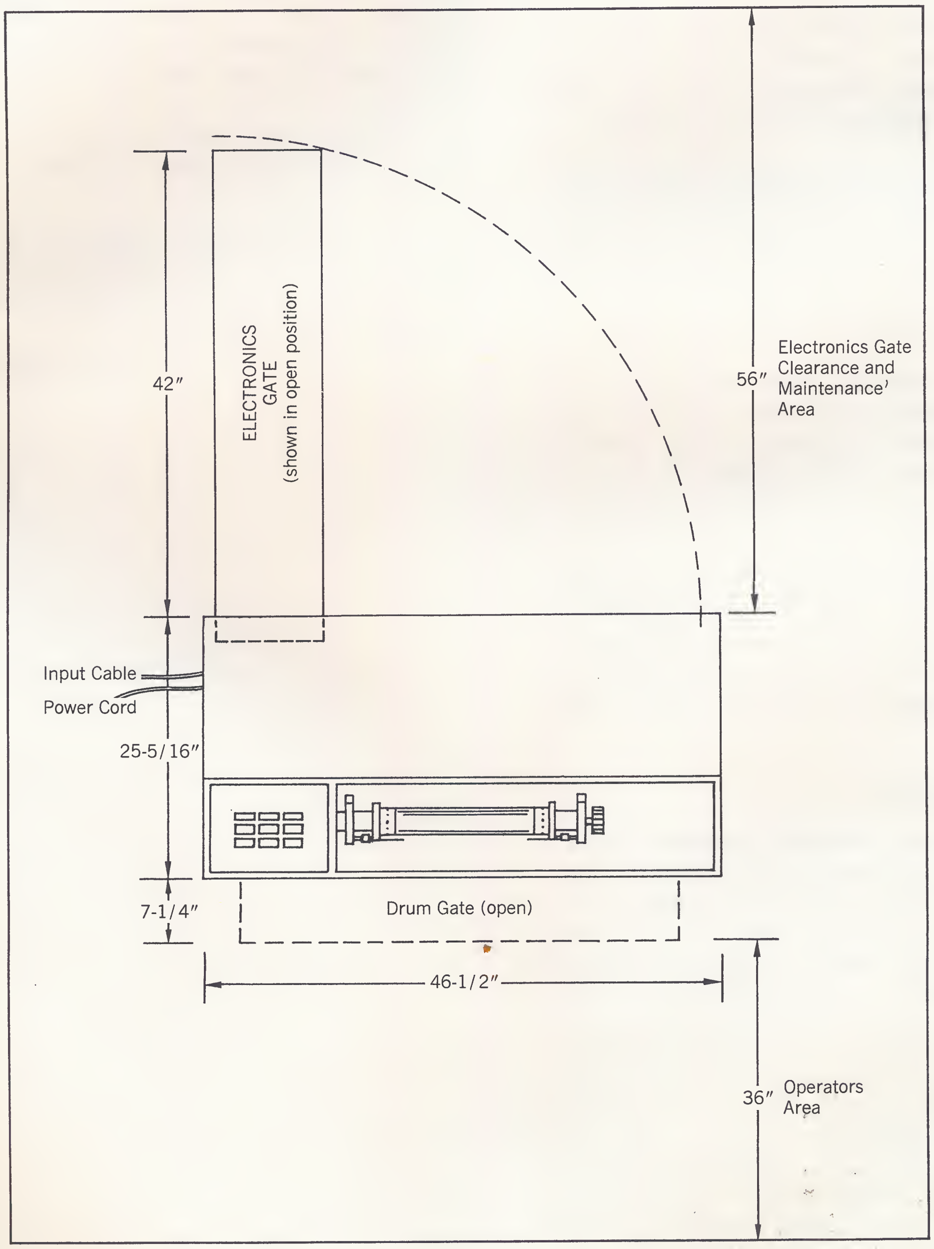


Figure 18 — Recommended Installation Area

GENERAL CHARACTERISTICS

POWER

Series 4000 LINE/PRINTERS require 1 kw, single phase, 115/120 volts ± 10 vac at 60 cps ± 1 cps. Printers may be ordered to suit line voltages from 115 to 240 volts in 10 volt increments and line frequencies from 48 to 62 cps. ± 1 cps. A single POWER ON push-button switch is illuminated when the power is on. This switch controls power to the blowers, the drum motor and the dc power supplies. Power sequencing relays correctly sequence power when the printer is switched on and off.

PHYSICAL CHARACTERISTICS

A 4000 Series LINE/PRINTER is 48 inches (122 cm) high, 46-1/2 inches (118 cm) wide, and 25-5/16 inches (64 cm) deep. Its weight is 650 pounds (295 kg). With shipping pallet, the weight is 750 pounds (340 kg.).

The recommended area for installation of the LINE/PRINTER is 7 by 9 feet 10 inches. Figure 18 shows a suitable installation arrangement which allows for easy access for maintenance purposes. The overhead clearance recommended for removing the cover is 80 inches. A minimum clearance to remove the cover is 65 inches.

Data and power cables are connected under the left side panel to the electronics gate. They may be brought straight through the floor if required. Cooling air enters from the bottom of the electronics gate.

ENVIRONMENT

The LINE/PRINTER should be operated in an air temperature of between 50 to 100°F (10 to 38°C) and relative humidity of 20 to 80%. The unit may be shipped or stored at any temperature between 0 and 125°F (18 and 51°C) with a maximum relative humidity of 95%, non-condensing.

QUALITY ASSURANCE

Data Products Corporation maintains complete facilities for electronic, electromechanical, and mechanical fabrication of parts and subassemblies for the Series 4000 LINE/PRINTERS. Data Products Corporation thus controls the manufacturing processes and tolerances required in the precision manufacture of this equipment. Semiconductors are built to Data Products' specifications and are certified as to compliance with these specifications.

A thorough and complete check sheet of all assemblies in each printer is maintained by the final assembly test group. As each purchase order is received, the functional requirements of the user are reflected in the assembly procedure used. In addition, quality control through the applications engineering group correlates the final test procedures to the customer's specifications, thus establishing a cross check on the original interpretation of these specifications.

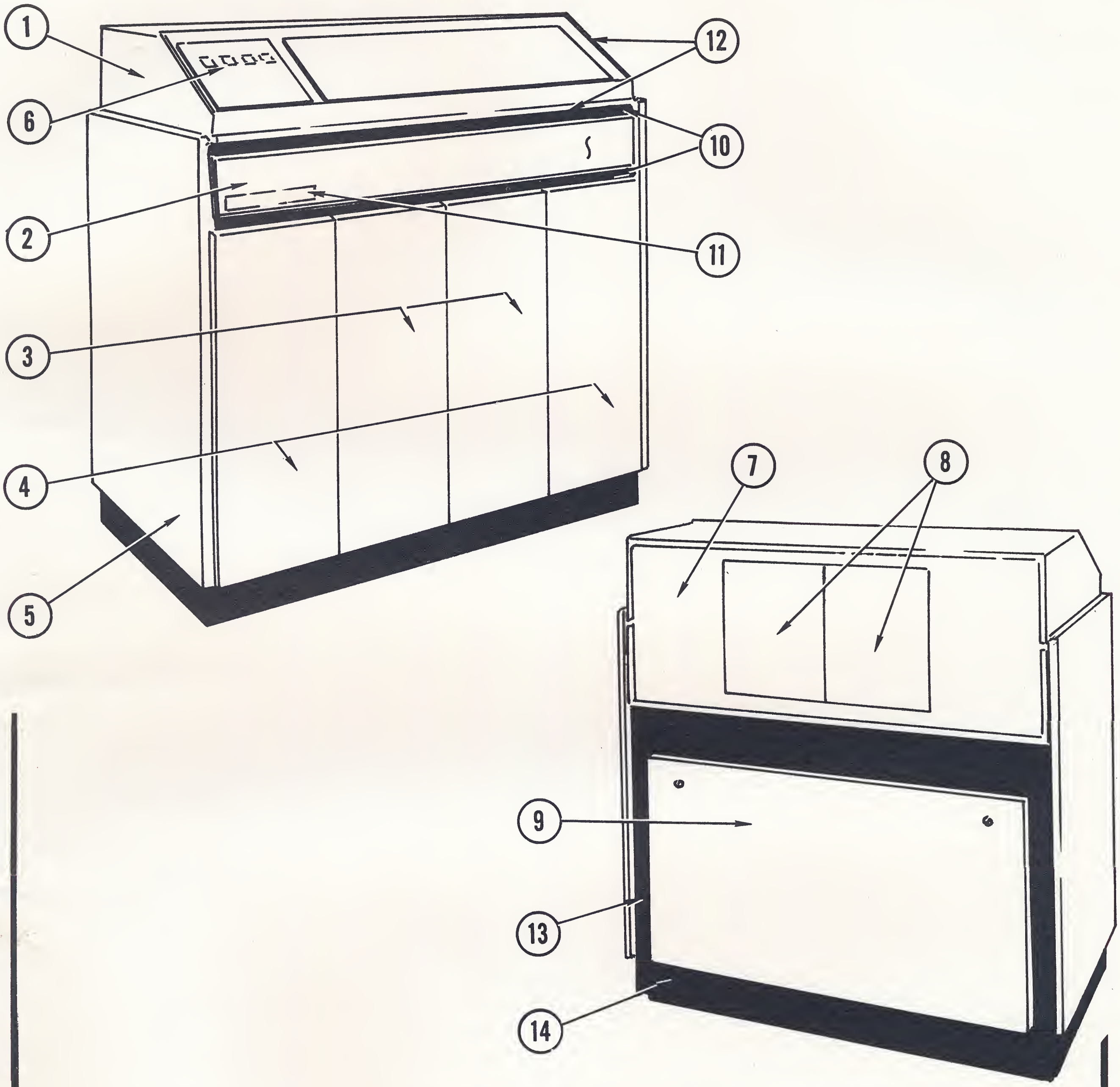
Each LINE/PRINTER is inspected in final test to an inspection checklist which has been devised to meet the specific function requirements of the customer. Long term reliability and freedom from error is assured by rigid inspection and control of all materials, components and processes at every stage of manufacture.

MAINTENANCE

Maintenance is reduced by the small number of different circuit cards, components, and special tools which are required. Access to the unit is convenient, and no obstruction is encountered in obtaining access to any internal part. The print drum and hammers are simple to replace.

Complete maintenance panels are available as options to check the equipment off-line.

The colors of the Series 4000 LINE/PRINTERS are light grey, dark grey, blue, and brushed aluminum. Special colors for some areas of the printers can be ordered as options. (See Figure 19.)



	NAME	COLOR AND FINISH (TEXTURED UNLESS STATED)	CUSTOMER'S DESIRED COLOR HERE
1	TOP COVER	DATA PRODUCTS DARK GRAY	
2	TRIM PANEL	DATA PRODUCTS BLUE	
3	FRONT DOORS	DATA PRODUCTS LIGHT GRAY	
4	FRONT DRESS PANELS	DATA PRODUCTS LIGHT GRAY	
5	SIDE DRESS PANELS	DATA PRODUCTS LIGHT GRAY	
6	OPERATOR'S PANEL	WHITE, SMOOTH	
7	COVER SUPPORT	DATA PRODUCTS DARK GRAY	
8	REAR DOORS	DATA PRODUCTS DARK GRAY	
9	REAR PANEL	DATA PRODUCTS LIGHT GRAY	
10	DRUM GATE	BLACK	
11	LOGO	DATA PRODUCTS COLORS	
12	BORDER AREA	BRUSHED ALUMINUM	
13	REAR GRILL	BLACK, SMOOTH	
14	PRINTER FRAME	BLACK, SMOOTH	

Figure 19 — Permissible Colors

Specifications

Drum Speeds: 360, 600, 1,000 rpm.

Lines per Minute: 360, 600, 1,000 (48 characters).

Characters per Line: 132 maximum. Available in 12, 24, 36, 48, 60, 72, 84, 96, 108, 120 and 132 column versions.

Characters per Inch: 10.

Maximum Available Characters per Drum Revolution: 64.

Paper Line Advance Time: 30 ms maximum from start of motion command to paper stop in 360 and 600 LPM Models; 20 ms for higher speed models.

Paper Skip Feed: 20 inches per second.

Ribbon: 1 inch wide, tabulator type, horizontally fed for 360 and 600 LPM Models; roll-type for higher speed models.

Character Synchronization: Effected by two variable reluctance pick-offs that sense drum position.

Paper Feed: Two pairs of tractors, accurately controlled by stepping motor drive.

Paper Dimensions: Standard, edge-punched (½ inch hole center) fanfold paper up to 19 inches wide and 22 inches long.

Print Area: From 1.2 inches to 13.2 inches, depending on number of columns selected.

Line-to-Line Spacing: 0.167 inches ±0.010 inches. 6 lines per inch.

Horizontal Alignment: Manual controls for positioning paper any place within the 19 inch feed area. Vernier controls for adjusting paper to ±1 character during operation.

Vertical Alignment: Vernier control up to ±1 line while operating.

Paper Loading: Printer drum housing with ribbon transport pivots forward permitting fast paper loading and ribbon replacement.

Paper Capability: Up to six parts, 12# bond, with single shot carbon or tabulating card (0.007 inches) plus second record sheet.

Single Copy Minimum Paper Weight: 15# bond.

Character Size: Open Gothic print characters with average face 0.095 inches ±0.003 inches high and 0.065 inches ±0.003 inches wide. Land width 0.008 inches ±0.001 inches.

Character Spacing: Horizontal character spacing 0.100 inches ±0.005 inches between centers. Maximum possible accumulative error for nominal horizontal spacing as listed above ±0.010 inches per 132 character line.

Line Straightness: Not more than 0.010 inches individual character deviation from a straight line drawn parallel to the line of characters.

Power: 115/200-240V ±10% AC in 10V increments. Any frequency selected between 48-62 cps ± 1 cycle. 1 Kw.

Weight: 650#/295kg. (With shipping pallet, 750#/340kg)

Cabinet Dimensions: Height: 48 inches, 122 cm; Width: 46½ inches, 118 cm; Depth: 25-5/16 inches, 64 cm.

Cabinet Color: Data Products light grey, dark grey, blue and brushed aluminum. Special colors optional.

Operating Environment: Maximum temperature 100°F/38°C, minimum temperature 50°F/10°C, maximum relative humidity 80%, minimum relative humidity 20%.

Non-Operating Environment: Maximum temperature 125°F/51°C, minimum temperature 0°F/−18°C, maximum relative humidity 95%, non-condensing.

Storage Capacity: One line of characters equal to the number of columns selected.

Input Speed: Asynchronous to 125 KC.

Signal Lines: Data lines (six): Send data, Paper instruction, Strobe, End of line, Parity (optional), Count or transfer address line and up to eight address input lines (optional).

Input Character Register: Accepts one character at a time, including optional parity.

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ii580/1/65/5M